

Geothermal Heat Pumps

What are they and how do they work?

Q: What is a geothermal heat pump?

A geothermal heat pump is an electrically powered device that uses the natural heat storage ability of the earth and/or the earth's groundwater to heat and cool your home or business.

Q. How does it work?

Like any type of heat pump, it simply moves heat energy from one place to another. Your refrigerator works using the same scientific principle. By using the refrigeration process, geothermal heat pumps remove heat energy stored in the earth and/or the earth's groundwater and transfer it to the home.

Q. How is the heat transferred between the earth and home?

The earth has the ability to absorb and store heat energy from the sun. To use that stored energy, heat is extracted from the earth through a liquid medium (groundwater or an anti-freeze solution) and is pumped to the heat pump or heat exchanger. There, the heat is used to heat your home. In summer the process is reversed and indoor heat is extracted from your home and transferred to the earth through the liquid.

Q. You mentioned heating and cooling - does it do both?

One of the things that makes a heat pump so versatile is it's ability to be both a heating and cooling system in one. You can change from one mode to another with a simple flick of a switch on your indoor thermostats. In the cooling mode, a geothermal heat pump takes heat from indoors and transfers it to the cooler earth through either groundwater or an underground loop system.

Q. Do I need separate ground loops for heating and cooling?

No. The same loop works for both. All that happens when changing from heating to cooling, or vice versa, is that the flow of heat is reversed.

Q. What types of loops are available?

There are two main types: open and closed. The next two sections will give you specifics about each.

Q. Does the underground pipe system really work?

The buried pipe or "ground loop" is the most recent technical advancement in heat pump technology. The idea to bury pipe in the ground to gather heat energy began in the 1940's but its only been in the last few years that new heat pump designs and improved pipe materials have been combined to make geothermal heat pumps the most efficient heating and cooling systems available.

Geothermal Heat Pumps: Closed loop systems

Q. What is a closed loop system?

The term "closed-loop" is used to describe a geothermal heat pump system that uses a continuous loop of special buried plastic pipe as a heat exchanger. The pipe is connected to the indoor heat pump to form a sealed, underground loop through which an antifreeze solution is circulated. Unlike an open-loop system that consumes water from a well, a closed-loop system re-circulates its heat transferring solution within a pressurized piping system.

Q: Where can this loop be located?

That depends on land availability and terrain. Most closed loops are trenched horizontally in yards adjacent to the home. But any area near a home or business with appropriate soil conditions and adequate square footage will work.

Q: How deep and long will my trenches be?

Trenches are normally four to six feet deep and up to 400 feet long, depending on how many pipes are in a trench. One of the advantages of a horizontal loop system is being able to lay the trenches according to the shape of the land. As a rule of thumb, 500-600 feet of pipe is required per ton of system capacity. A well insulated, 2,000 square foot home would need about a three-ton system with 1,500-1,800 feet of pipe.

Q: How many pipes are in a trench?

Normally, a run of pipe is laid at five feet then looped back over itself at three feet once the bottom pipe is covered with soil. This allows more length of pipe to be put in one trench and has no adverse affect on system efficiency. Other loop designs use four or six pipes and allow for shorter trenches if land area is limited.

Q: What if I don't have enough room for a horizontal loop?

Closed-loop systems can also be vertical. Holes are bored to about 120 - 150 feet per ton of heat pump capacity. U-shaped loops of pipe are inserted in the holes. The holes are then backfilled with a sealing solution.

Q. How long will the loop pipe last?

Closed-loop systems should only be installed using high density polyethylene or polybutylene pipe. Properly installed, these pipes will last 50-75 years. They are inert to chemicals normally found in soil and have good heat conducting properties. PVC pipe should not be used under any circumstances.

Q: How are the pipe sections of the loop joined?

The only acceptable method to connect pipe sections is by thermal fusion. Pipe connections are heated and fused together to form a joint stronger than the original pipe. Mechanical joining of pipe for an earth loop is never an accepted practice. The use of barbed fittings, clamps and glued joints is certain to result in loop failure due to leaks.

Q: Will an earth loop affect my lawn or landscape?

No. Research has proven that loops have no adverse effect on grass, trees or shrubs. Most horizontal loop installations use trenches about six inches wide. This, of course, will leave temporary bare areas that can be restored with grass seed or sod. Vertical loops require little space and result in minimal lawn damage.

Q: Can I reclaim heat from my septic system disposal field?

No. An earth loop will reach temperatures below freezing during extreme conditions and may freeze your septic system. Such usage is banned in many areas.

Q: If the loop falls below freezing, will it hurt the system?

No. The antifreeze solution in the loop will keep it from freezing down to about 10 degrees F. Three types of antifreeze solution are acceptable: propylene glycol, calcium chloride and methyl alcohol.

Q: Can I install an earth loop myself?

It's not recommended. In addition to thermal fusion of the pipe, good earth coil contact is very important for successful loop operation. Non-professional installations may result in less than optimum system performance.

Q: I have a pond near my home. Can I put a loop in it?

Yes, if it's deep enough and large enough. A minimum of six feet in depth at its lowest level during the year is needed for a pond to be considered. In pond loops, copper, polyethylene or polybutylene pipe can be used.

Geothermal heat pumps: Open loop systems:

Q: What is an open-loop system?

The term "open-loop" is commonly used to describe a geothermal heat pump system that uses groundwater from a conventional well as a heat source. The groundwater is pumped into the heat pump unit where heat is extracted, and then the water is disposed of in an appropriate manner. Since groundwater is a relatively constant temperature year-round, it is an excellent heat source.

Q: What do I do with the discharge water?

There are a number of ways to dispose of water after it has passed through the heat pump. The open discharge method is the easiest and least expensive. Open discharge simply involves releasing the water into a stream, river, lake, pond, ditch or drainage tile. Obviously, one of these alternatives must be readily available and must possess the capacity to accept the amount of water used by the heat pump before open discharge is feasible.

A second means of water discharge is the return well. A return well is a second well bore that returns the water to the ground aquifer. A return well must have enough capacity to dispose of the water passed through the heat pump. A new return well should be installed by a qualified well driller. Likewise, a professional should test the capacity of an existing well before it is used as a return.

Q: How much groundwater does an open-loop system need?

Geothermal heat pumps used in open-loop systems need differing amounts of water depending on the size of the unit and the manufacturer's specifications. The water requirement of a specific model is usually expressed in gallons per minute (g.p.m.) and is listed in the specifications for that unit. Your heating contractor should be able to provide this information. Generally, the average system will use ~10 g.p.m. while operating.

Your well and pump combination should be large enough to supply the water needed by the heat pump in addition to your domestic water requirements. You will probably need to enlarge your pressure tank or modify your plumbing to supply adequate water to the heat pump.

Q: What problems can be caused by poor water quality?

Poor water quality can cause serious problems in open-loop systems. Your water should be tested for hardness, acidity and iron content before a heat pump is installed. Your contractor or equipment manufacturer can tell you what level of water quality is acceptable. Mineral deposits can build up inside the heat pump's

heat exchanger. Sometimes a periodic cleaning with a mild acid solution is all that's needed to remove the build-up.

Impurities, particularly iron, can eventually clog a return well. If your water has high iron content you should be sure that the discharge water is not aerated before it's injected into a return well.

Finally, you should opt against using water from a spring, pond, lake or river as a source for your heat pump system unless it's proven to be free of excessive particles and organic matter. They can clog a heat pump system and make it inoperable in a short time.

Q: Does an open-loop system cause environmental damage?

No. They are pollution free. The heat pump merely removes heat from or adds heat to the water. No pollutants are added whatsoever. The only change in the water returned to the environment is a slight increase or decrease in temperature.

Some people are concerned that open-loop systems contribute to the depletion of our ground water resources. This issue is not critical in some parts of North America because of abundant supplies of groundwater.

Q: Are there any laws that apply to open-loop Installations?

In some localities, all or parts of the installation may be subject to local ordinances, codes, covenants or licensing requirements. Check with local authorities to determine if any restrictions apply in your area.

Geothermal heat pumps: Parts of the system

Q: What are the components of a geothermal heat-pump system?

The three main parts are:

1. The heat-pump unit.
2. The liquid heat exchanger medium (open or closed loop).
3. The air-delivery system (ductwork).

Q: Are all geothermal heat pumps alike?

No. There are different kinds of geothermal heat pumps designed for specific applications. Many geothermal heat pumps, for example, are intended for use only with higher temperature ground water encountered in open-loop systems. Others will operate at entering water temperatures as low as 25 degrees F which are possible in closed-loop systems.

Most geothermal heat pumps provide summer air conditioning, but a few brands are designed only for winter heating. Sometimes these heating-only systems incorporate a groundwater cooled coil that can provide cooling in moderate climates. Geothermal heat pumps can also differ in the way they are designed. Self contained units combine the blower compressor, heat exchanger and coil in a single cabinet. Split systems allow the coil to be added to a forced-air furnace and utilize the existing blower.

Q: Will I have to add insulation to my home if I install one of these systems?

Geothermal heat pumps will reduce your heating and cooling costs regardless of how well your home is insulated. However, insulating and weatherizing are key factors in realizing the most savings from any type of heating and cooling system.

Q: Can a geothermal heat pump also heat water for my home?

Yes. Using what's called a desuperheater, some types of geothermal heat pumps can save you up to 50 percent on your water heating bill by preheating tank water. Desuperheaters are standard on some units, optional on others. Some geothermal models can provide all of your water needs on demand at the same high efficiencies as the heating cooling cycles.

Q: Is a geothermal heat pump difficult to install?

Most units are easy to install, especially when they are replacing another forced-air system. They can be installed in areas unsuitable for fossil fuel furnaces because there is no combustion, thus, no need to vent exhaust gases. Ductwork must be installed in homes that don't have an existing air distribution system. The difficulty of installing ductwork will vary and should be assessed by a contractor.

Q: Can a geothermal heat pump be added to my fossil fuel furnace?

Split systems can easily be added to existing furnaces for those wishing to have a dual-fuel heating system. Dual-Fuel systems use the heat pump as the main heating source and a fossil fuel furnace as a supplement in extremely cold weather if additional heat is needed.

Q: I have ductwork, but will it work with this system?

In all probability, yes. Your installing contractor should be able to determine ductwork requirements and any minor modifications, if needed.

Q: Do I need to increase the size of my electric service?

Geothermal heat pumps don't use large amounts of resistance heat, so your existing service may be adequate. Generally, a 200-amp service will have enough capacity, and smaller amp services may be large enough in some cases. Your electric utility or contractor can determine your service needs.

Q: Should I buy a heat pump large enough to heat my home with no supplemental heat?

Your contractor should provide a heating and cooling load calculation (heat loss, heat gain) to guide your equipment selection. Geothermal heat pumps are sized to meet your cooling requirements. Depending on your heating needs, a geothermal heat pump will supply 80 to 100 percent of your design heating load. Sizing the heat pump to handle your entire heating needs may result in slightly lower heating costs, but the savings may not offset the added cost of the larger heat-pump unit. Also, an oversized unit can cause dehumidification problems in the cooling mode, resulting in a loss of summer comfort.

Q: Do geothermal heat pumps have outdoor units?

No. The equipment goes inside your home, usually in the basement, garage or crawl space. Because it's indoors, the lifespan of the compressor and major components are greatly extended, most having a lifespan of 20 years or more.

Geothermal heat pumps: What are the major benefits?

Q: How efficient is a geothermal heat pump?

They are more than three times as efficient as the most efficient fossil fuel furnace. Instead of burning a combustible fuel to make heat, they simply move heat that already exists. By doing that, they provide three units of energy for every one unit used to power the heat-pump system.

Q: What does a system like this cost?

A system for the typical home will cost more than if you bought a separate furnace and central air-conditioning system. But you wouldn't really be comparing apples to apples. To get an accurate comparison of costs you need to consider the following:

- Payback or how long it takes to recover the difference in costs between the two systems using energy savings. Payback for most geothermal heat-pump systems runs two to six years.

- Energy efficiency of the two Systems. To get an accurate picture, make sure efficiency claims are substantiated. Your lifestyle and how well your home is insulated affect how economical a system will be.
- Total operating savings from heating, cooling and domestic hot water must be combined to get an accurate picture of total energy savings.
- Energy costs and availability, both present and future.
- Maintenance costs and system reliability • System lifespan.

Q: What about comfort?

A geothermal heat pump system moves warm air (90 degrees - 105 degrees) throughout your home via a standard duct network. Typically, a very even comfort level is found throughout the home. This is because the warm air is moved in slightly higher volumes and, therefore, saturates the home with warmth more evenly. This helps even out hot or cold spots and eliminates the cold air blast common with fossil fuel furnaces. It's also a great comfort to know that you've reduced your energy consumption while using an inexhaustible energy source - the earth.

Q: Can I get a tax credit for installing this system?

It depends on where you live. Some states and provinces do have tax credits for installing geothermal systems. Check with your electric utility, Department of Commerce or Ministry of Revenue for further details.

Q: Which system is best, open - or closed loop?

The net results in operating cost and efficiency are virtually the same. Which system to choose depends mainly on whether you have an adequate groundwater supply and means of disposal. If you do, an open loop can be used very effectively. If not, either a horizontal or vertical closed-loop system is your best choice. Over a period of years, a closed-loop system will require less maintenance because it's sealed and pressurized, eliminating the possible build-up of minerals or iron deposits.

Questions you should ask about a new heating system

Regardless of the type of heating system you may be considering for your home or business, there are specific questions you should ask the dealer installer. These questions deal with finding out the actual efficiency of the system, any operating limitations it may have, and the bottom line of operating costs. The answers here are meant as a guide for what you should try to find out with your questions.

Q: What is the Btu size of the furnace that's being proposed?

Furnaces are designed to provide specific amounts of heat energy per hour. The term 'Btuh' refers to how much heat can be produced by the unit in an hour. Before you can know what size furnace you'll need, you must have a heat loss/heat gain calculation done on your home. From that, an accurate determination can be made on the size of the heating system you'll need. Most fossil fuel furnaces are substantially oversized for home heating requirements, resulting in increased operating costs.

Q: Is the efficiency rating actual or just a manufacturer's average?

All types of heating and cooling systems have a rated efficiency. Fossil fuel furnaces have a percentage efficiency rating. Natural gas, propane and fuel oil furnaces have efficiency ratings based on laboratory conditions. To get an accurate installed efficiency rating, factors such as flue gas heat losses, cycling losses caused by over sizing, blower fan electrical usage, etc., must be included.

Geothermal heat pumps, as well as all other types of heat pumps, have efficiencies rated according to their coefficient of performance or COP. It's a scientific way of determining how much energy the system produces versus how much it uses.

Most geothermal heat pump systems have COP's of 2.5 - 3.5. That means for every one unit of energy used to power the system; two and one-half to three and one-half units are supplied as heat.

Where a fossil fuel furnace may be 50-90 percent efficient, a geothermal heat pump is about 300 percent efficient. Some geothermal heat pump manufacturers and electric utilities use computers to accurately determine the operating efficiency of a system for your home.

Q: Will the minimum entering water temperature have an affect on which heat pump I buy?

Yes. If you have an open-loop system, your entering water temperatures may range from the 70s in the southern United States to the 40s in Canada. All heat pumps can handle temperatures in the moderate to warm ranges. A closed-loop system, on the other hand, will encounter EWT's below freezing. Not all geothermal heat pumps will operate efficiently at those temperatures. It's important for you to know what EWT's your heat pump will handle.

Q: Are the dealer and loop installers qualified?

Don't be afraid to ask for references from dealers. A reputable dealer won't hesitate to give you names and numbers to call to confirm his capabilities. The same with the loop installer.

Q: Will open or closed-loop be best for you?

That depends on several factors, as stated earlier. A dealer should be willing to install what's best for you, not for him.

Q: Will the loop joints be heat fused?

The only acceptable method for joining sections of the special pipe used for closed-loop systems is heat fusion. Any other method will eventually result in failure of the loop.

Q: How long is the payback period for your geothermal heat pump system?

To figure this accurately, you must know how much per year you'll save in energy costs with a geothermal system and the difference in costs between it and a conventional heating system and central air conditioner. As an example: If you'll save \$700 per year with a geothermal system and the cost difference is \$2,000, your payback will be less than three years.

Q: If a home has ceiling cable heat or baseboard heat, do air ducts need to be installed?

Not always. It may be desirable to install geothermal heat pump room units. For some small homes, one room unit would provide most of the heating and cooling needs. Ceiling cable or baseboard units could then be used for supplemental heat.

Q: If I want to know more about geothermal heat pump systems, whom should I contact?

YOUR ELECTRIC UTILITY. Most electric utilities have information about these systems. If you have a question they can't answer, they will put you in contact with someone who can.

Remember! Your Electric Utility Wants You To Be An Informed, Efficient User Of Electricity. Contact Them Any Time You Have A Question About Heating And Cooling Systems.

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